INTRODUCTION
Relative micromotion induced from under-reaming at the acetabular cup/bone interface in immediate post-operative phase can restrict ingrowth threatening long term fixation of non-cemented acetabular cups. To better characterize the under-reaming micromotion of the interface under loading conditions, an experimental and finite element (FE) study was undertaken. In this study cadaver semi-pelvices were implanted with cementless acetabular cups and detailed parametric finite element model, validated with experimental results, was developed to further analyze the conditions affecting the initial stability and loosening of the interface for different loading conditions. This model will allow the development of a patient specific system for predicting the nature of a cup bone interface based on CT scan and bone density data.

METHODS
Twelve cadaver semi-pelvices were implanted with non-cemented acetabular cups using a 2mm under-reaming technique [1]. Micromotion at the cup bone interface was quantified with six displacement sensors placed on the rim of the acetabular cup. Due to the limitation of number of cadavers validated 3D FE model was used to investigate the stability of the cup/bone interface. Software was created to obtain bone geometry and mesh from CT scan data. The experimental results were challenged in the finite element model by using values of under-reaming which are above and bellow the standard 2mm in increments of 0.25mm. Bone density which plays an important role in cup/bone interface stability, was also taken into consideration. Bone mineral density for all the specimens was measured using DEXA scanning.

RESULTS AND DISCUSSION
Values of relative micro motions between the acetabular cup and the bone obtained from the experiment are shown in figure 2. The model predicted values of micromotion that agreed with experimental data with less than 5% error.

The degree of micromotion has been shown to be related to cup diameter, bone density, surface roughness and value of under-reaming (Table 1) which are defined as parameters in the model.

Figure 2 Relative micromotions between the acetabular cup and the bone
Under-reaming the acetabulum by 1.75mm will lead to increase in stability by 8% compared to 2mm. Increasing the value of under-reaming to 2.5mm will significantly reduce implant stability by 24%. Although the higher values of cup/bone interference are theoretically conductive to better implant stability, the high stress in the subchondral bone may compromise the integrity of the press fit. A multifactorial model will be created to recognize a patient scenario where under normal gait an upper limit of 50 μm of micromotion may be exceeded. This may aid the surgeon in selecting the value of under-reaming and predicting when micromotion may be a problem. In this scenario, the use of adjunctive fixation such as screws may be required to minimize micromotion and insure ingrowth.

Table 1 Effect of under-reaming to acetabular cup stability

<table>
<thead>
<tr>
<th>Value of under-reaming</th>
<th>Increase in stability (%)*</th>
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<tbody>
<tr>
<td>1.75</td>
<td>8</td>
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<tr>
<td>2.25</td>
<td>-12</td>
</tr>
<tr>
<td>2.50</td>
<td>-24</td>
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* Compared with under-reaming of 2mm

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REFERENCES